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EGU25-8558

Ecosystem multifunctionality is positively affected by remotely sensed biodiversity at global eddy covariance sites

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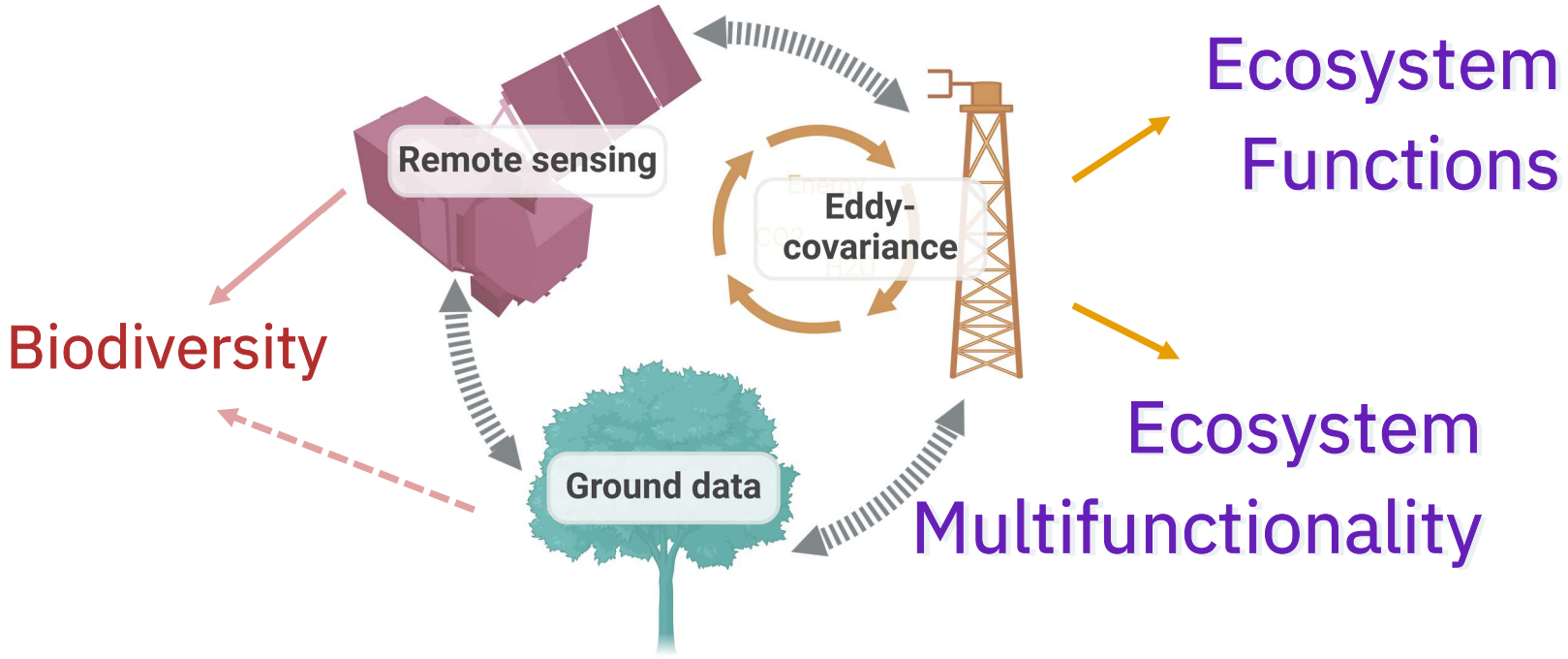
[4] European Commission, Joint Research Centre, Italy

[5] German Centre for Integrative Biodiversity Research (iDiv), Germany

Overview



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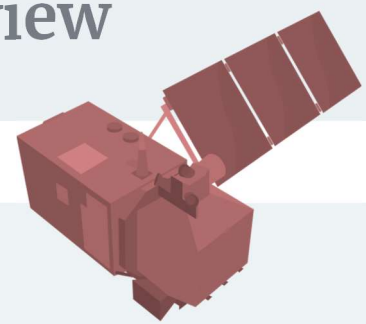
Overview



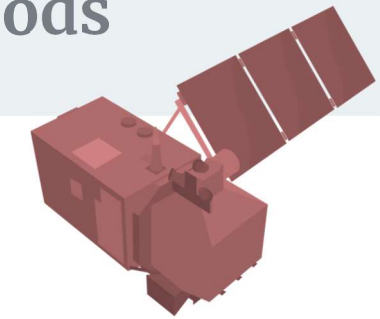
Biodiversity

Ecosystem Functions

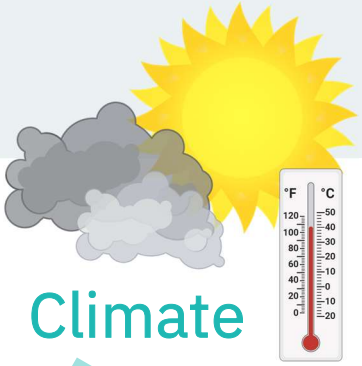
Ecosystem Multifunctionality

Ulisse Gomarasca, Max Planck Institute for Biogeochemistry, Germany.

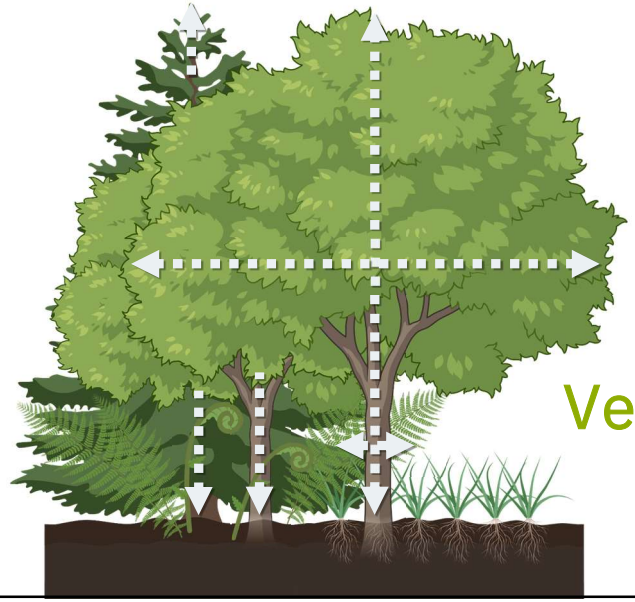
Methods



Biodiversity



Climate



Vegetation structure

METHOD
multi-model inference

Ecosystem Functions

Ecosystem Multifunctionality

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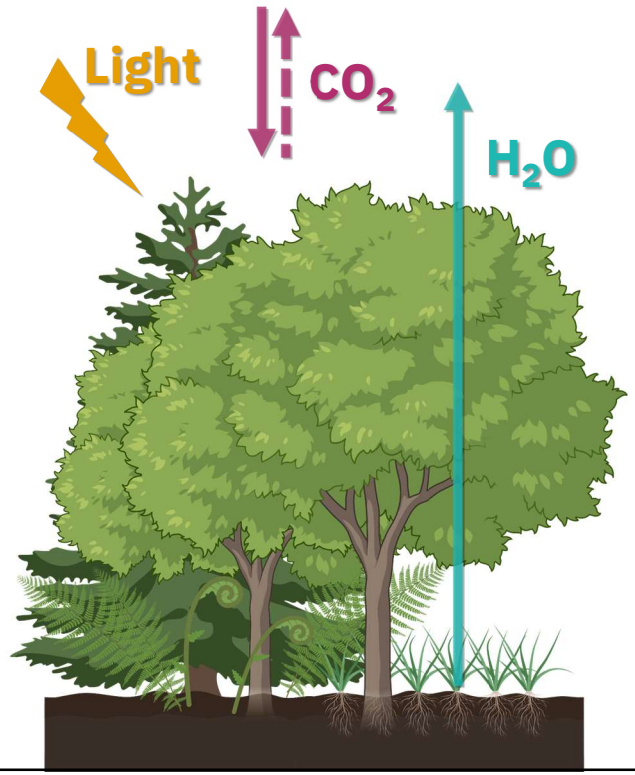
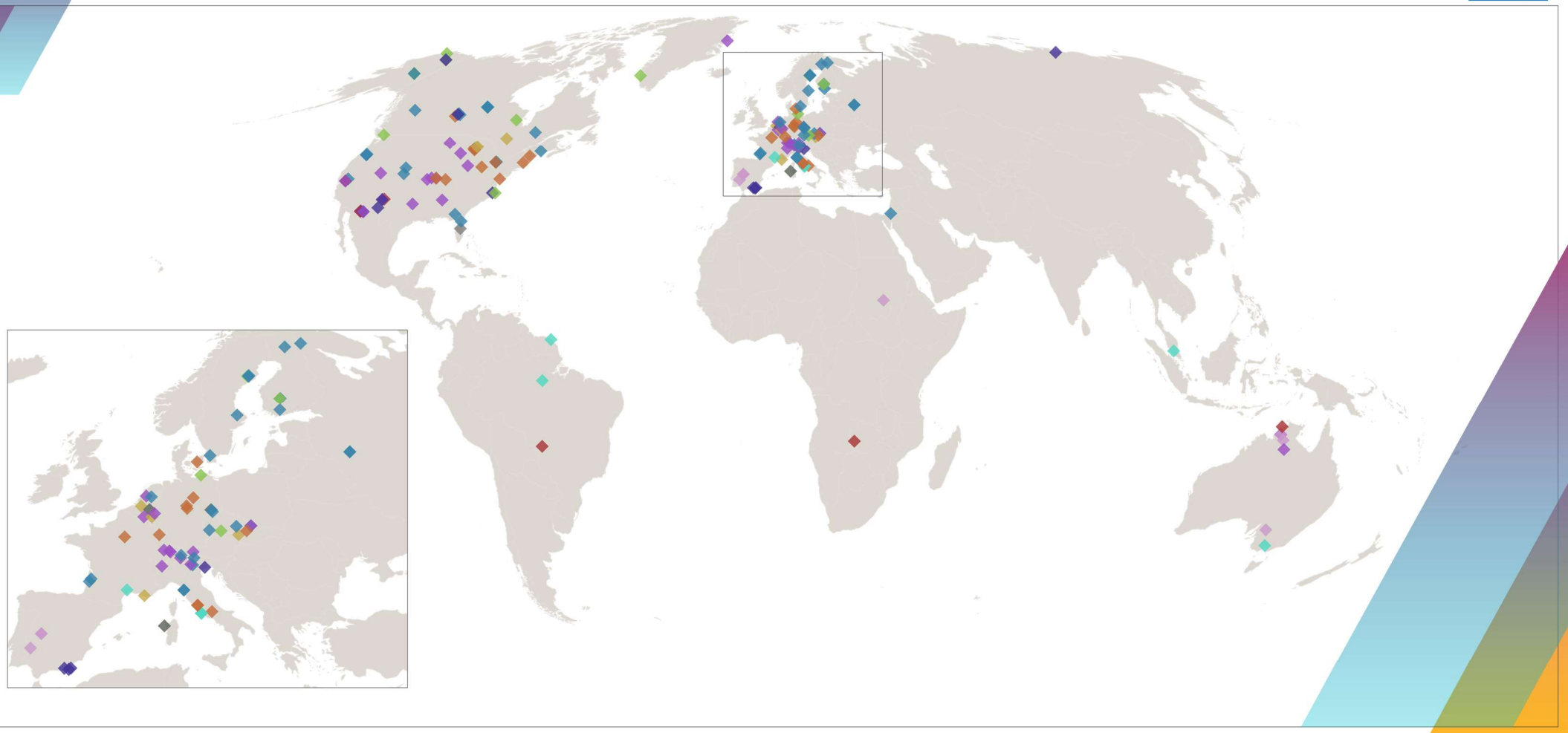
Ecosystem Functions



- Maximum Net Ecosystem Productivity (NEP_{max})
- Photosynthetic capacity (GPP_{sat})
- Carbon Use Efficiency (CUE_{eco})
- Surface conductance (Gs_{max})
- Water Use Efficiency (WUE)

- "Summarized": **Multifunctionality**

Global dataset



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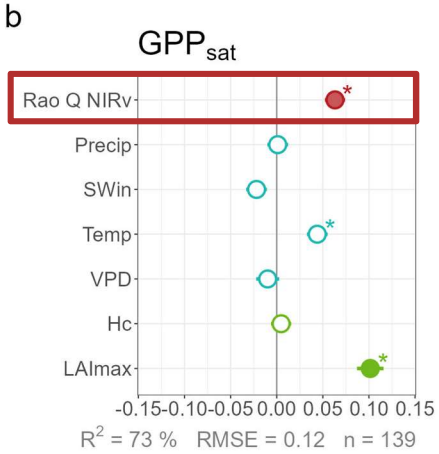
Biodiversity – Ecosystem Functions



Gomarasca et al., in preparation

Predictor type

- Biodiversity
- Climate
- Structure

Relative importance

- 0%-10%
- 10%-20%
- 20%-30%
- 30%-40%
- 40%-100%

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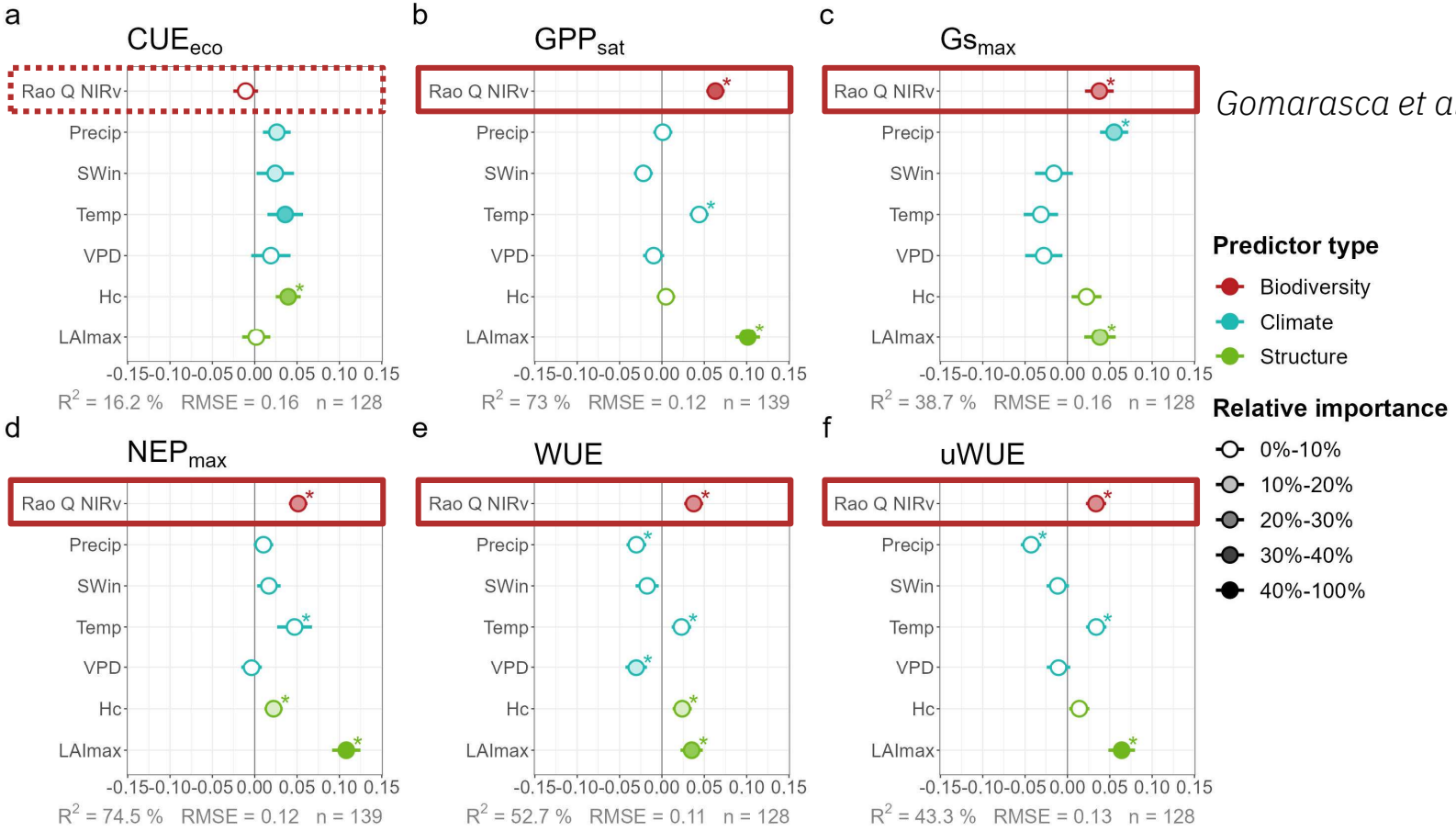
Biodiversity – Ecosystem Functions



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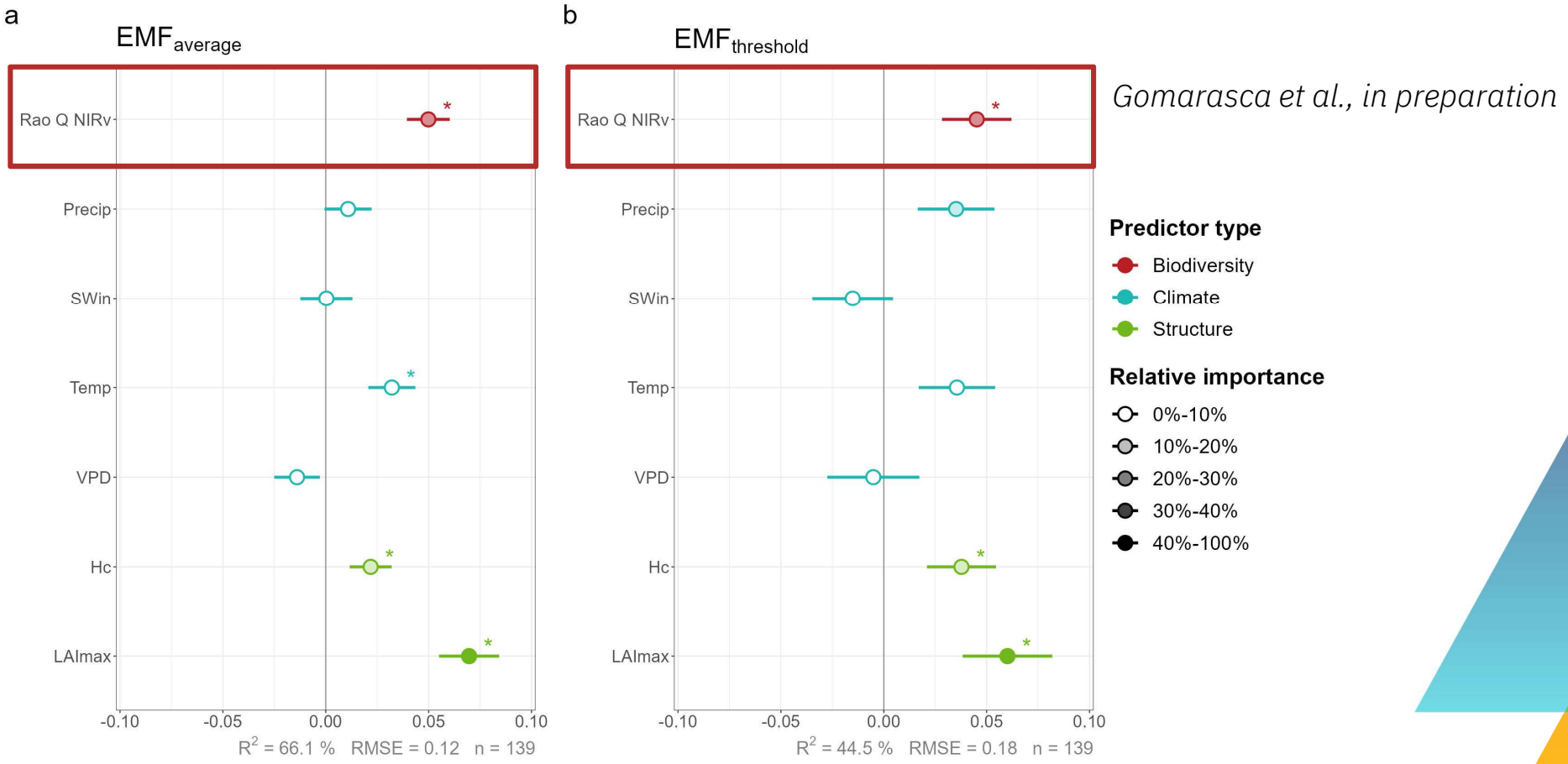
Biodiversity – Multifunctionality



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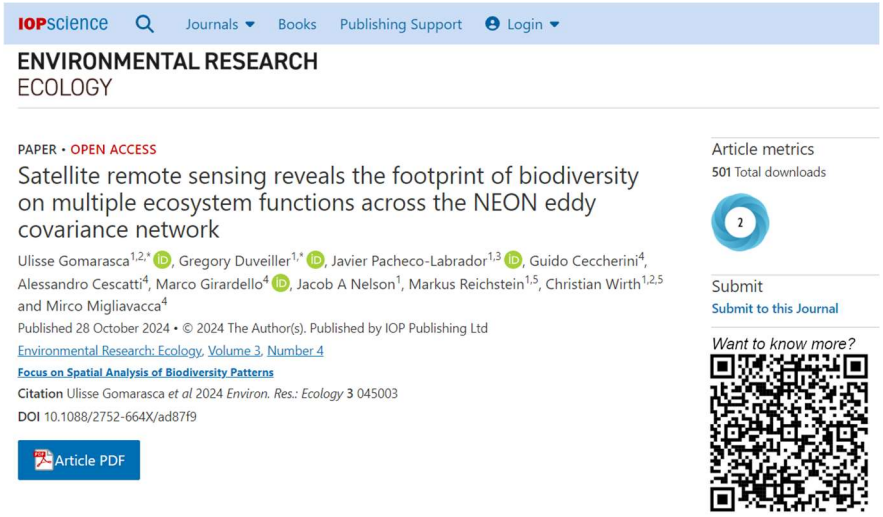
Summary

- Biodiversity generally positively affects ecosystem (multi-) functionality globally at the ecosystem scale



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Satellite remote sensing reveals the footprint of biodiversity on multiple ecosystem functions across the NEON eddy covariance network

Ulisse Gomarasca[1,2,*], Gregory Duveiller[1,*], Javier Pacheco-Labrador[1,3], Guido Ceccherini[4], Alessandro Cescatti[4], Marco Girardello[4], Jacob A Nelson[1], Markus Reichstein[1,5], Christian Wirth[1,2,5] and Mirco Migliavacca[4]

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Focus on Spatial Analysis of Biodiversity Patterns

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Want to know more?

- Spectral heterogeneity (Rao Q) can characterize the global B-EF relationship (NIRv > NDVI)

References & Contacts

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Schematic visualizations created with BioRender.com

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UNIVERSITÄT LEIPZIG

MAX PLANCK INSTITUTE FOR BIOGEOCHEMISTRY

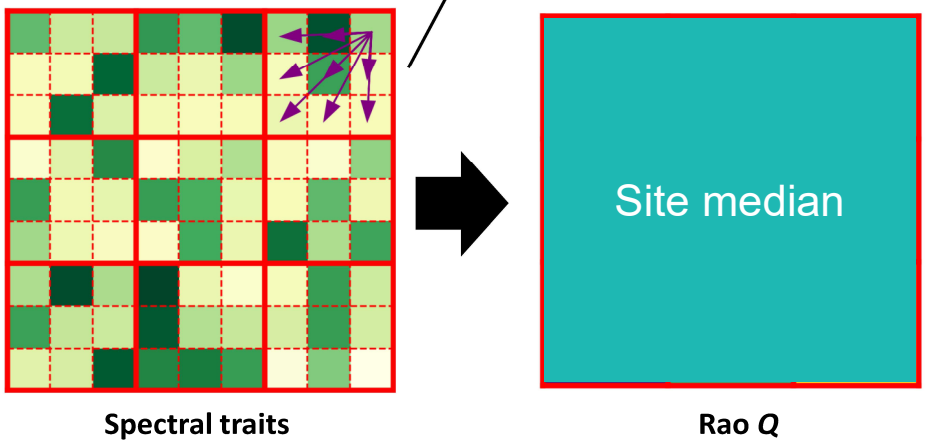
IMPRS for Global Biogeochemical Cycles
INTERNATIONAL MAX PLANCK RESEARCH SCHOOL

Supplementary slides

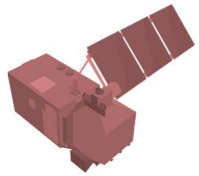
Biodiversity metrics

- **Rao's Q**: difference between spectral values in 3x3 pixel windows (Rocchini et al., 2017, Pacheco-Labrador et al., 2023)

$$\text{Rao}Q = \sum_{i,j}^{N} p_i p_j d_{ji} = \sum_{i,j}^{N} \frac{1}{N^2} d_{ji}$$



- From Sentinel 2 at 20 m



  - All bands (visible, NIR)
  - $\text{NDVI} = \frac{\text{NIR} - \text{red}}{\text{NIR} + \text{red}}$
  - $\text{NIRv} = \frac{\text{NIR}}{\text{NDVI}}$

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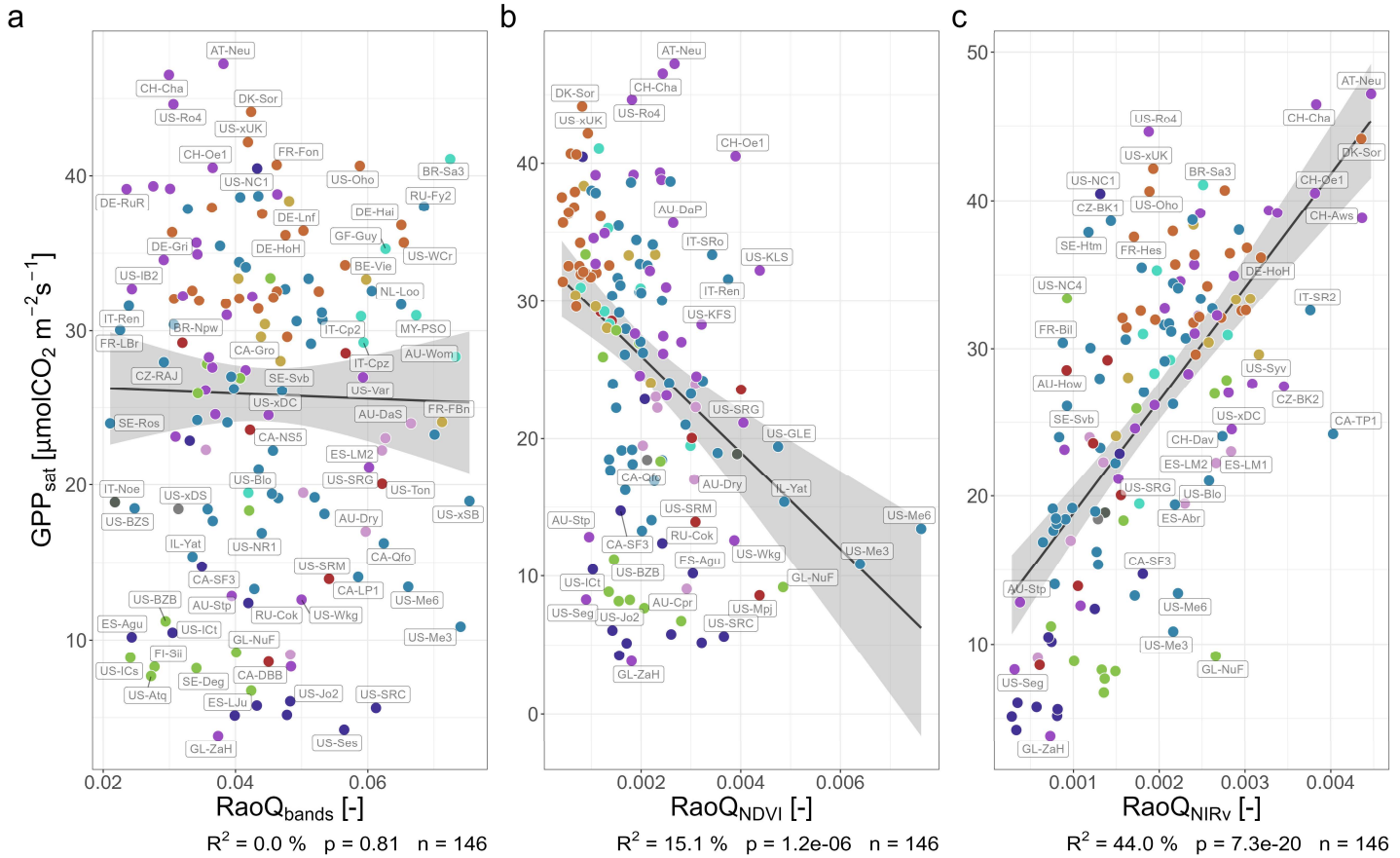
Rao Q: choice of vegetation index



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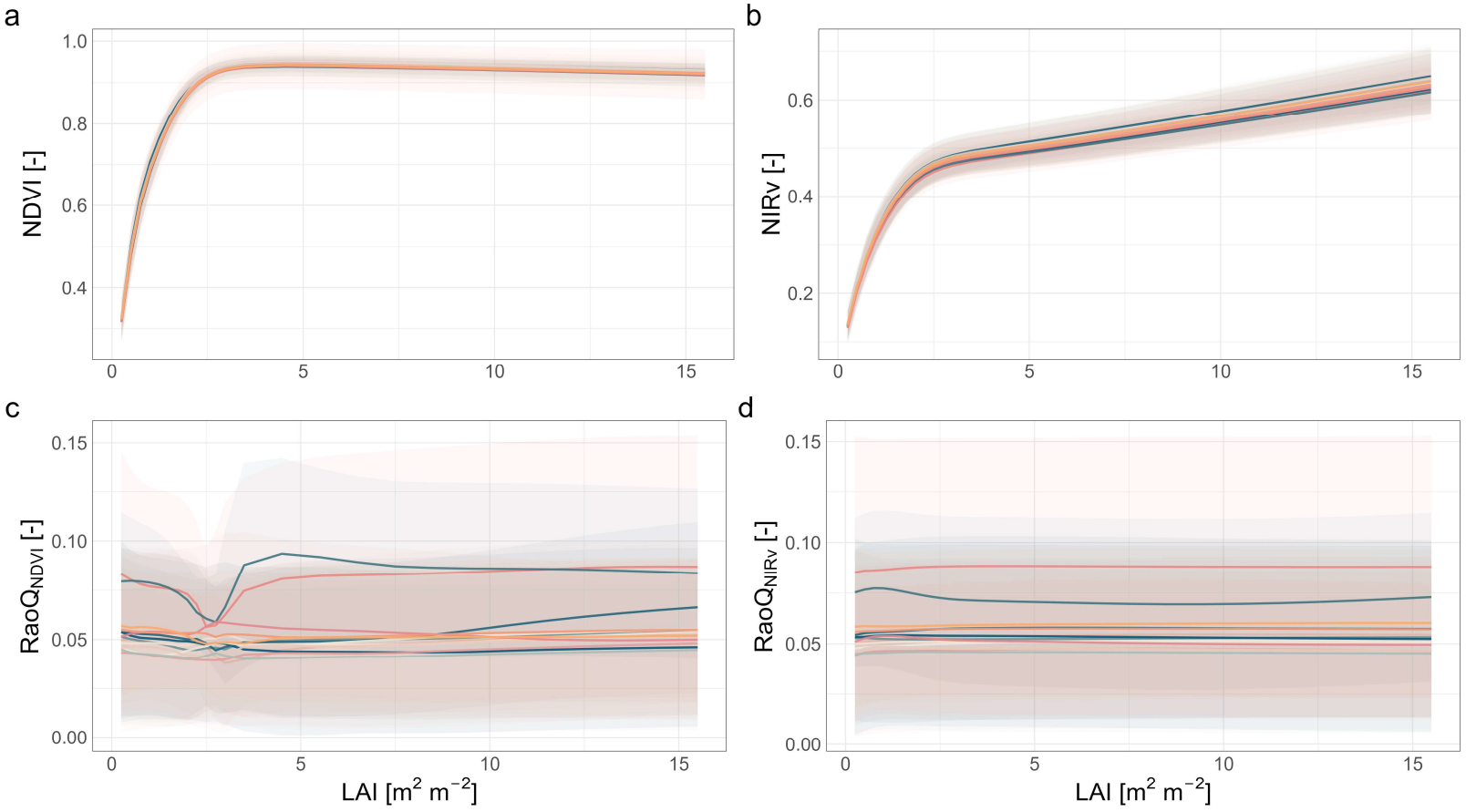
Rao Q choice: simulations



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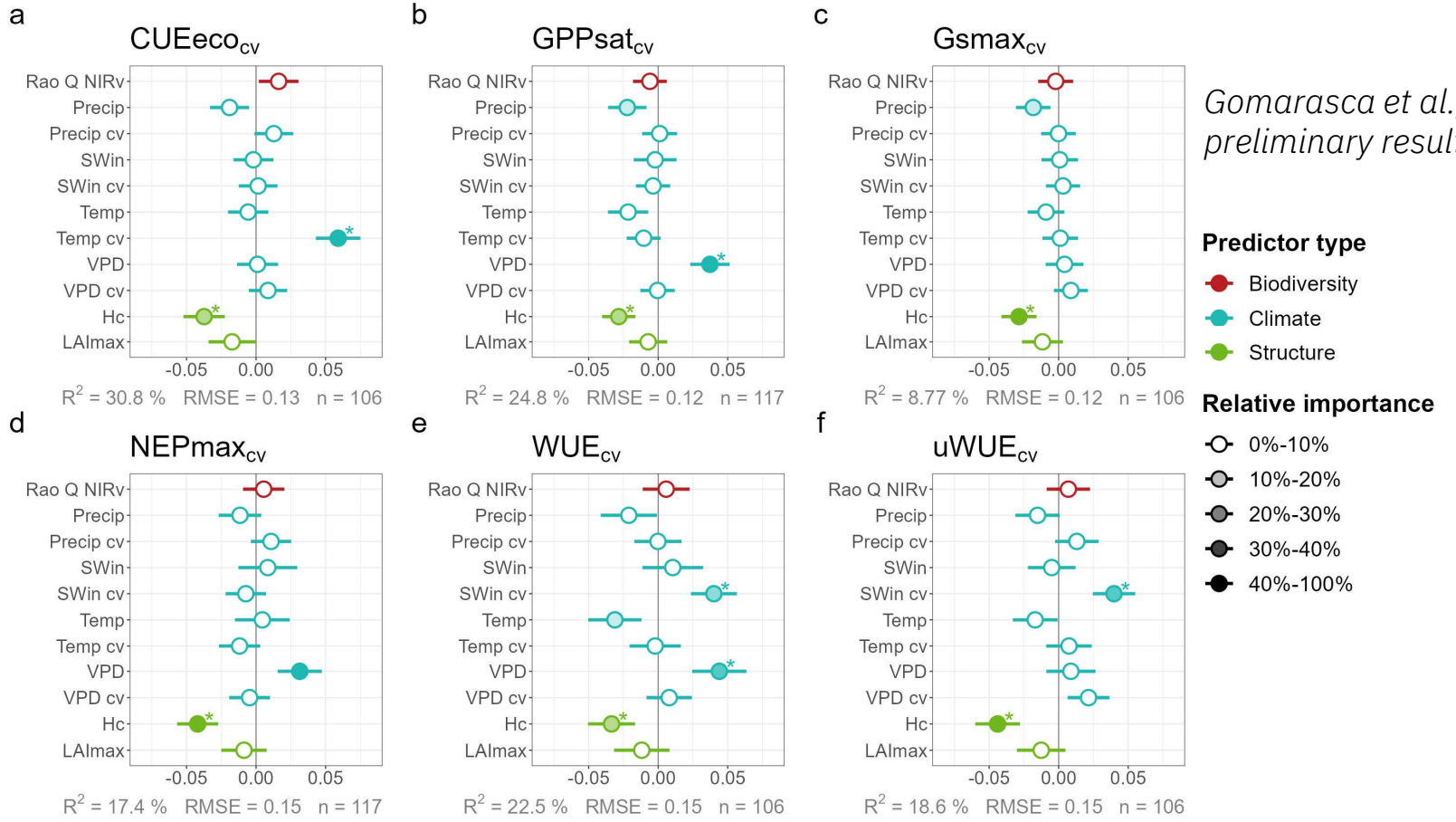
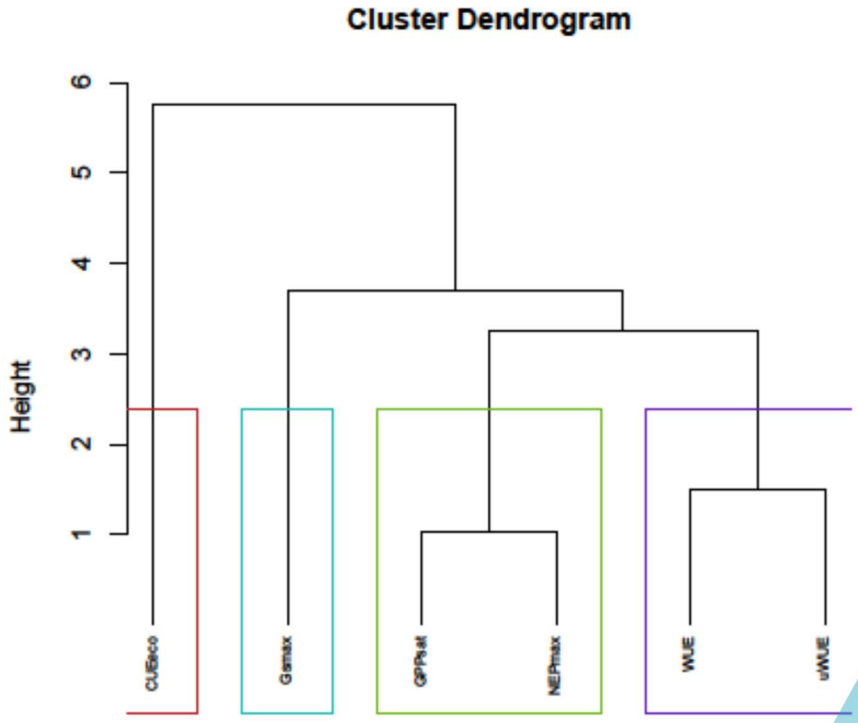
Ecosystem Stability



Gomarasca et al., preliminary results

Ecosystem Multifunctionality (EMF)

- Cluster analysis (Manning et al., 2018)
- Average of EFPs
- Threshold of EFPs above 0.5



Methods

Predictors

- Biodiversity (ground/satellite)
- Meteorology
- Structure

Ecosystem functional properties

- NEP_{max}
- GPP_{sat}
- CUE_{eco}
- Gs_{max}
- WUE
- uWUE

Multi-model inference

- Automatic model selection and averaging
- Based on AIC
- Linear models

Relative importance analysis

Ecosystem Functional Properties

- Surface conductance (Gsmax) = 90th percentile of half-hourly surface conductance from inverted Penman-Monteith equation (Migliavacca et al., 2021)
- Carbon-use efficiency (CUEeco) = 90th quantile regression slope of half-hourly ratio NEP/GPP
- Photosynthetic capacity (GPPsat) = maximum half-hourly GPP under optimal light conditions in 5 days moving windows (Musavi et al., 2016)
- Net Ecosystem Productivity (NEPmax) = 95th percentile of harlf-hourly NEP
- Water-use efficiency (WUE) = GPP / ET
- uWUE = underlying water-use efficiency = $GPP \cdot \sqrt{(VPD)} / ET$